

The Sidereal Messenger.

CONDUCTED BY WM. W. PAYNE,

Director of Carleton College Observatory.

APRIL, 1886.

CONTENTS:

By faith we understand that the worlds have been framed by the word of God, so that which is seen hath not been made out of things which do appear.

ARTICLES:—

	Page.
The Images of the Stars. ASAPH HALL.....	97
The Relation between Meteoric Orbits and Radiants. S. J. CORRIGAN.....	100
Solar and Magnetic Observations.....	105
The Cometary Meteor Showers. W. F. DENNING.....	106
Orbits of Meteors. O. C. WENDELL.....	111
Proposed Maps for Tracing Meteor Paths. T. W. B. in Observatory.....	114
Elements of the Orbit of Comet Barnard 1886. J. MORRISON.....	118
The Red Spot on Jupiter. G. W. HOUGH.....	119

EDITORIAL NOTES:—

Galle's Catalogue.—The Naval Observatory.—Chronograph Pens.—Elements of Comets Fabry and Barnard.—Saturn and Mu Geminorum.—A List of the Warner Prizes.—Comets Fabry and Barnard.—Double Star A. C. 5, (8 Sextantis).—Dark Transit of Jupiter's Satellite III.—Astronomical Work for Amateurs in Preparation.—The Red Sunsets.—Tuttle's Comet.—New Instruments by Fauth & Co..... 120-128

BOOK NOTICE:—

Primary Phenomenal Astronomy. By F. H. BAILEY, Northville, Michigan 128

The Messenger will be published monthly except for July and September. Subscription price per year (ten numbers) \$2.00. Communications should be addressed to the Editor, Northfield, Minnesota.

NORTHFIELD, MINN.

CARLETON COLLEGE OBSERVATORY.

Entered at the Post Office at Northfield, Minn. and admitted for transmission through the mails at second-class rates.

JOHN A. BRASHEAR,

Manufacturer of

Refracting and Silvered-glass Reflecting Telescopes,

Specula, Plane Mirrors,

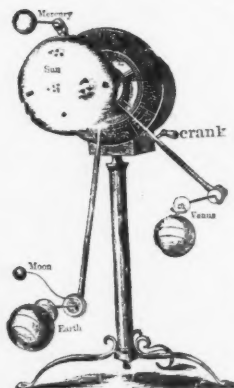
And Mirrors for special purposes of Speculum Metal or Glass.

Parallel Plates, Polarizing and Solid Eye-pieces.

Glass and Rock Salt Prisms, Diffraction Grating Plates, Grating Spectroscopes, Telespectroscopes, Heliostats, Driving Clocks,

and general Optical Apparatus. ACCURATE SURFACES OUR SPECIALTY.

Address, Observatory Avenue, Alleghany, Pa.



HELIOTELLUS

When the Earth's axis is pointed to the north, it will continue so pointing throughout the revolution, and will be in the Ecliptic. The Earth rolls over from west to east, and if the Equator be continued to the sky, it will meet the Equinoctial. So with the Ecliptic, if continued, it will come near to the Moon, near to Mercury, near to Venus, and always to the Sun.

I have now in my possession all the Heliotelluses for sale, made with a set of tools costing \$25,000, which tools were afterwards destroyed by fire. They were so accurately made that the Heliotellus cannot now be duplicated for less than \$250 each. The greatest impediment I find in their introduction is the Tellurian, which makes a false showing of the heavenly movements. It is a device in which the Earth's axis wobbles around the zenith and never points to the north. This is the greatest barrier to the comprehension of this most sublime of the sciences. The Heliotellus shows so near the truth that it is not hard to comprehend.

In high schools, seminaries, colleges, and all places of learning we find many globes and maps of the earth, but where can one be found having the Equator of the Earth so constructed that if continued it will meet the Equinoctial in the right place on the sky? Every child should have a truthful understanding of science. The Ecliptic should be correctly understood. All instruments which show imperfect teaching are hurtful; those which teach correctly are useful. The one should be rejected, the other sought for, and when found, should be prized even as a "pearl of great price." Three hundred such I now possess, all perfectly made, and I now propose to sell two hundred at the reduced price of \$20 each, or for \$65, the price of one, I will send four, each well packed in a strong box to carry by express anywhere.

Address,

HENRY WHITALL,
1019 N. 3d St. Camden, N. J.

The Sidereal Messenger

CONDUCTED BY WM. W. PAYNE,

Director of Carleton College Observatory, Northfield, Minnesota.

"In the present small treatise I set forth some matters of interest to all observers of natural phenomena to look at and consider."—GALILEO, *Sidereus Nuncius*, 1610.

VOL. 5. No. 4.

APRIL, 1886.

WHOLE No. 44.

THE IMAGES OF THE STARS.

BY ASAPH HALL.

For The Messenger.

The variability of the images of stars from night to night, when seen in the same telescope, is very great, and the blurred and indefinite shape the stars sometimes assume is one of the chief difficulties in making accurate measurements for the more delicate determinations of astronomy. Since the quality of the image varies with the season, this difficulty becomes a serious one in the determination of quantities that have a year for their period; such as the constant of aberration, and the parallaxes of the stars. Observations for these determinations must be made at times of the year six months apart, and if the stars are so situated that the maximum coefficients occur in summer and winter, there is apt to be a decided and continuous difference in the quality of the images which may produce a sensible error in the measurements. This difficulty becomes more apparent as we use large objectives and high magnifying powers. A part of the trouble comes from the increased aperture of the objective, which increase gives a greater opportunity for changes of temperature to affect the images, but there appears to be a considerable part of the change that is independent of the objective and which depends on the season.

At Washington, my experience during the year is as follows: We get fair images of the stars occasionally in the latter part

of February, and in March we generally have a few good nights. In April and May the weather is changeable, and good seeing is rare. June brings somewhat better images of the stars; and the longest period for good work is from July to October. But there is sometimes a break in this period during September, with a return of good images until the middle of October. In the early part of October I have seen very fine images of the stars and planets in the morning sky. After the middle of October the seeing becomes bad, and continues so through November and the early part of December. When the cold weather has completely set in we sometimes have good images for a few days in the latter part of December and in the early part of January, before the wet winter weather begins. This is the general course of the images throughout a year.

It would be interesting to examine the meteorological changes in connection with the variations of the images of the stars, but this I can do only in a very imperfect manner. It does not appear that moisture in the air of itself prevents good seeing or injures transparency, since in the months of July and August a damp night, preceding a rain will frequently give very fine seeing. Such nights are calm and quiet, and are those on which we hear distant sounds so distinctly. On these nights, the 26-inch CLARK refractor will bear the highest powers, and there seems to be almost no limit to its performance. It will resolve the most delicate double-star, and bring to view faint objects that on common nights are far beyond its reach. As autumn comes on and the weather becomes colder, the moisture produces a different effect, so that in November a night before a storm generally gives blurred and fuzzy images of the stars. I have sometimes imagined that these bad images may be caused by ice crystals forming in the atmosphere, which scatter the light and produce a confusion of the image. As the weather gets still colder and drier, the images become better, so that occasionally in mid-winter we have a good night. But damp and chilly weather at this season nearly always pro-

duces bad seeing, and as the stars become blurred and indistinct we may be pretty sure that a storm of snow or rain is approaching. It is possible that the changes caused by the seasons may be avoided in a good degree in the equatorial regions of the *Earth*.

Besides the regular changes brought about by the seasons of the year, there are changes produced by local causes. Thus from one day to another there will be a great difference in the appearance of the stars, even when the sky remains apparently quite clear. In fact, such changes occur from one hour to another during the same night. Probably these sudden changes are caused by the passage of large bodies of air of different temperature and moisture, since after a short time, perhaps even a half-hour, the images which have suddenly become poor will as suddenly become good again. I have found that during any night the best seeing is generally in the morning sky, say from three o'clock until sunrise. This is especially the case in the summer and autumn months, when the hours preceding morning twilight are frequently excellent. At that hour of the night, the temperature has become steady, and the conditions of the observing room and of the instrument are the best. It is surprising to notice how great is the difference in the quality of the seeing on different nights, and this is shown best of course with faint and difficult objects. *Mimas*, the inner satellite of *Saturn*, is a good example. Generally this satellite can not be seen at conjunction, and even at elongation it is not an easy object; but on a fine night it can be seen at conjunction with ease in our 26-inch refractor. The difference of visibility is so great that at times one is inclined to believe that such objects are variable in light; but probably the true explanation lies in the varying transparency of our atmosphere.

Such considerations bring us to a question which is destined, I think, to become an important one in the future of astronomy, that is, the selection of the best sites for our large telescopes and delicate photographic apparatus. There are certain evident

advantages to the astronomer in being near large libraries, and in having convenient access to mechanics and workshops; and our human nature is such that it is pleasant to be near clubs and hotels, theaters and churches. But the great foes of the astronomer are the variability and sudden changes of our atmosphere. As observations become more and more refined, as well as the tools with which we work, the need of better positions for our instruments will be seriously felt, and will finally outweigh the little inconveniences of life.

**THE RELATION BETWEEN METEORIC ORBITS AND
RADIANTS.**

S. J. CORRIGAN.

For the Messenger.

In the February number of the MESSENGER, I set forth a method of computing the orbital elements of meteoric streams from the observed position of the radiant point, the formulæ of that method having been derived from fundamental equations of motion as found in works on "Celestial Mechanics."

This method is a facile one and gives results of sufficient accuracy in all cases, but the determination of the elements may be effected by an equally easy process, devised by me some years ago, which is perfectly rigorous and which has, moreover, the advantage of disclosing certain facts concerning a mooted question in "Meteoric Astronomy," which facts do not *explicitly* appear in the former method.

The question to which reference is made is that relating to the cause of the phenomena of stationary radiants. The labors of expert observers seem to leave no doubt as to the existence of meteor streams emanating from the same, or very nearly the same, point of the celestial sphere for a considerable length of time, and several hypotheses have been framed to account for this phenomenon which seems to conflict with the heretofore generally accepted hypothesis, viz.: that the meteors, like the comets, move around the *Sun* in orbits whose eccentricities are approximately that of the parabola.

I now propose this second method of computation, mainly

for the purpose of demonstrating that the position of a radiant is, in most cases, not a *true* but only an *apparent* position, and that stationary or long-enduring radiation of meteors from nearly the same point in the heavens, does not necessarily imply a real connection between all the meteors emanating from such stationary radiant, nor that they all belong to the same stream, but rather that there is probably no connection whatever.

From the actual application of this method to certain cases of well-marked stationary radiation, I also hope to prove that the hypothesis of nearly parabolic motion is not weakened by the existence of such radiants, but corroborated, and that it is unnecessary to construct any other hypothesis to explain the phenomenon.

The principle upon which the method above mentioned is founded, may be briefly stated as follows: It is well known that the radiant point of a meteor stream is the vanishing point of the parallel lines apparently described on the celestial sphere by the individual members of the stream during their flight through the *Earth's* atmosphere; it may therefore be regarded as situated at an infinitely great distance from the observer.

Then, since the members of the stream approach the orbit of the *Earth* with nearly parabolic velocity, while the latter body is also in motion, it follows that the *true* position of the radiant point will be affected by the composition of the velocities of the *Earth* and of the meteors, in a manner perfectly analagous to that in which the position of a fixed star is affected by aberration.

In other words the observed position of the radiant is not a *true* but only an *apparent* position.

Since the axis of the meteor stream, or the line passing through the *true* position of the radiant and through the center of the *Earth*, may be taken as the tangent to a parabola at a point where the radius-vector is equal to R , or the radius-vector of the *Earth*, it becomes very easy to compute the elements of the parabolic orbit if we can reduce the observed radiant to its *true* position. This reduction may be effected in the following manner:

Let L = Longitude of *Sun*
 " π = " " *Sun's* perigee
 " R = *Earth's* radius vector
 " e = Eccentricity of *Earth's* orbit

In the first place the orbit of the *Earth* being slightly elliptical, the true direction from which the *Earth* is moving at any instant will not be equal to $(90^\circ + L)$ as it would if the orbit were a circle, but would differ from that value by a small angle, i , which depends upon the eccentricity of the *Earth's* orbit. From an equation of curvature and the polar equation of the

$$\text{ellipse we obtain } \tan i = \frac{e \sin (L - \pi')}{1 + e \cos (L - \pi')} \quad (1)$$

Then if, instead of taking the *Sun's* true longitude L , we use $L' = L - i$, the change of direction will be taken into account. Then to derive the *true* position of the radiant, we have only to solve two right-angled spherical triangles, having one common angle B , the sides opposite to this angle being b , or the latitude of the observed radiant, and b' or the latitude of the *true* radiant; the sides adjacent to the right angles are $90^\circ + (L' - l')$ and $90^\circ + (L' - l)$, which are arcs of the ecliptic included between that longitude from which the *Earth* is moving, and the apparent and the true longitudes of the radiant point, respectively.

The composition of the velocities of the *Earth* and of the meteors will have the effect of extending the hypotenuse in the direction of the *Earth's* motion; t' or the hypotenuse of that spherical triangle whose other sides are the *observed* co-ordinates $90^\circ + (L' - l')$ and b' , being greater than t , or the hypotenuse of that triangle whose other sides are the *true* co-ordinates $90^\circ + (L' - l)$ and b .

Having the observed longitude l' and latitude b' , the following equations will give l and b , or the true longitude and latitude of the radiant point.

$$\left. \begin{aligned} \sin t' \sin B &= \sin b' \\ \sin t' \cos B &= \cos b' \cos (L' - l') \\ \cos t' &= -\cos b' \sin (L' - l') \end{aligned} \right\} \quad (2)$$

From which we obtain B and t' :

$$\text{Then } c = \sqrt{1 - \frac{R}{2}} \quad (3)$$

$$\sin (t' - t) = c \sin t' \quad (4)$$

From (4) we obtain t ; then from the equations

$$\left. \begin{aligned} \sin t \sin B &= \sin b \\ \sin t \cos B &= \cos b \cos (L-l) \\ \cos t &= -\cos b \sin (L-l) \end{aligned} \right\} \quad (5)$$

we obtain l and b , or the true longitude and latitude of the radiant point. Finally, from the following equations we may readily obtain the parabolic elements:

$$d = 180^\circ + (L - l)$$

$$\cos a = \cos b \cos d$$

$$\cot i = \cot b \sin d$$

$$q = R \sin^2 a$$

$$v = 180^\circ - 2a$$

$$\pi = L + 2a$$

$$\Omega = L \text{ when } b \text{ is positive}$$

$$\Omega = 180^\circ + L \text{ when } b \text{ is negative}$$

i is always taken to be less than 180° and the motion is retrograde when $\cot i$ is negative.

To show the change produced in the position of the radiant by the composition of the velocities of the *Earth* and of the meteors, I have taken a peculiar case of stationary radiation mentioned by Mr. DENNING in No. 8 Vol. 45 of the *Monthly Notices of the Royal Astronomical Society*, page 444 *et seq.* I quote therefrom: "Let us take the instance of the display from near Epsilon *Persei*, at R. A. $61^\circ 8'$; Dec. $+36^\circ 8'$, No. IV of my list in the *Monthly Notices* for December, 1884, page 101, which I regard as one of the very best cases of stationary radiation.

A shooting star of about the third magnitude was doubly observed from this shower at York and Oxford at 11h 28½m, on August 10, 1872. The estimated duration was 0.5 second and the actual length of the path traversed in the atmosphere was 20.4 miles, so that the resulting velocity was about 41 miles per second; the radiant point was at R. A. 61° ; Dec. $+39^\circ$. A great fireball from the same stream was observed at Bristol and many other parts of England on November 6, 1869 at 6h 50m. Prof. HERSCHEL discussed a considerable number of observations and found the radiant point at R. A. 62° ; Dec. $+37^\circ$. The meteors had a real path of about 175 miles, traversed in about

five seconds the velocity being some 35 miles per second and somewhat greater than that of a body moving in a parabola, etc., etc.

The facts contained in the above statement by Mr. DENNING offer an excellent means of learning something of the nature of stationary radiants. From the position of the radiant point of these two fireballs I have computed the elements of their orbits by the method which I have just given, and also by that which I set forth in the February number of the MESSENGER, and the results agree exactly. They are as follows:

Elements	Meteor of November 6, 1869	Meteor of August 10, 1872
Longitude of node	224° 27'	138° 35'
“ “ perihelion	272 54	263 19
Inclination	38 44	33 29
Perihelion distance	0.1873	0.7952
Motion	Direct	Retrograde

The apparent longitude of the November radiant was $67^{\circ} 4'$ and its latitude $+15^{\circ} 45'$, but the true longitude as obtained through the computation by the above given method was $23^{\circ} 49'$, and the true latitude $+15^{\circ} 47'$.

The apparent longitude of the August radiant was $66^{\circ} 41'$ and its apparent latitude $+17^{\circ} 52'$, but its *true* longitude as computed was $80^{\circ} 42'$ and its true latitude $+29^{\circ} 16'$.

Thus we see that two meteors having their apparent radiants within two degrees of each other and affording, as Mr. DENNING states, an excellent example of stationary radiation, are, in reality, members of entirely distinct streams, as their elements show, and that their *true* radiants are separated by the great distance of more than fifty-eight degrees. The agreement of the elements derived through the two different methods proves the accuracy of the computation on the hypothesis of parabolic motion, and also that the *observed* position of the radiant is only an *apparent* position.

We have, finally, to consider whether the hypothesis of nearly parabolic motion is sufficiently satisfactory.

The question as to what form of conic section any heavenly

body revolves in is determined by finding, through places observed at certain intervals, the form of orbit that will pass through these places, or an orbit that will possess such elements that will enable one to compute therefrom places that will well agree with those observed. This virtually amounts to the determination of the linear velocity of the body upon which the form of orbit depends. The rapidity of flight of a meteor precludes the institution of such a comparison, but we can directly compare the linear velocity, as deduced from computation with the velocity when it is actually obtained from observation, as it was in the case of the two meteors under consideration. In the case of the meteor of 1872 the observed velocity was about 41 miles per second and the velocity given by my computation was 41 miles per second, an exact agreement. The observed velocity of the meteor of 1869 was 35 miles per second, while my computation gives only 26 miles; but this difference may very easily have resulted from errors of observation in the case of a body moving so swiftly.

It would seem therefore that the above comparisons of linear velocities and also the comparisons of computed and observed velocities in the case of the twenty meteor streams whose elements were given by me in the February No. of the *MESSENGER*, furnish strong evidence in favor of the hypothesis of approximately parabolic motion.

This being granted, it seems unnecessary to propose abnormally great velocities for the meteors to explain the phenomenon of stationary radiants.

WASHINGTON D. C. February 8, 1886.

SOLAR AND MAGNETIC OBSERVATIONS.—We are glad to learn from private advices, that a small observatory will soon be fitted up with the necessary instruments for continuous solar and local magnetic observation, in which daily solar photographs of the *Sun* will form an important part of the work done by the observers. We are not aware that work of this kind is now anywhere systematically undertaken in the U. S.—Ed.

THE COMETARY METEOR SHOWERS.

W. F. DENNING.

For the Messenger.

The very valuable data, in connection with meteoric orbits, given by Mr. S. J. CORRIGAN in the February issue of the MESSENGER, leads me to send you some further details of meteor observations which seem to require mathematical investigation. This branch of astronomy is so recent that it is far from being understood in all its relations. Our aim therefore should be to obtain full and exact observations, and thoroughly sift them, so that theory and observations may mutually harmonize.

The physical connection of comets and meteor streams has been definitely proved in a few instances. The character of their orbital agreements is such that no one can doubt the fact of their identity. But these instances may be regarded as special. Very rich meteor displays like the *Lyrids*, *Perseids*, *Leonids* and *Andromedes* are not typical of the multitude of very feeble showers which the *Earth* encounters. It is fair to suppose that every variety of orbit exists among them, and that, in certain cases, abnormal features are recognized which are not to be satisfactorily explained on prevailing ideas.

My present intention is simply to refer to the acknowledged cometary showers. In connection with these it is important to ascertain whether the epoch and radiant point show an exact coincidence with that computed for the cometary orbit and whether the maximum displays of the meteors agree with the periodical returns of their derivative comets. It is also necessary to determine the visible duration of the meteor showers, and to note whether the point of radiation is stationary or shifts from night to night amongst the fixed stars. Having obtained some evidence on these matters during the last ten years I have summarized it as follows:—

The April Meteors (Lyrids).—This shower is far less rich than formerly. The radiant point of its associated comet

(I 1861) is at $270.^{\circ}5 + 32^{\circ}$ April 20+ (A. S. HERSCHEL). The early determinations of the meteor shower by GREG, HERSCHEL and others, placed the radiant several degrees to the north-east of the cometary radiant, hence their assumed identity was considered questionable. I find that the radiant of the meteors is at $269.^{\circ}1 + 33.^{\circ}4$, which is very close indeed to that indicated by the cometary orbit. The maximum occurs on April 20 with the *Sun* in longitude 31° . The shower endures for five or six nights and the radiant point moves very rapidly amongst the stars. In 1885 on three very clear nights I obtained sharply defined radiants at the following places:—

1885	G. M. Time.	Radiant Point.	No. of Meteors.
April 18.....	12h to 14h 30m.....	$260^{\circ} + 33\frac{1}{2}^{\circ}$	6
19.....	10h 30m to 14h.....	$267\frac{1}{2} + 33$	10
20.....	11h 30m to 15h 30m.....	$274 + 33\frac{1}{2}$	14

The motion is in R. A. toward the east, carrying the observed radiant from the stars of *Hercules* to those of *Lyra*.

The August Meteors (Perseids).—This stream contributes an annual display not differing much in intensity. Prof. HERSCHEL gives the radiant of its companion comet (III 1862) as $43^{\circ} + 57.^{\circ}5$ August 10—. I find the meteor radiant is at $44.^{\circ}4 + 57.^{\circ}4$ on August 10. The accordance is excellent. The shower is definitely and certainly sustained over at least twenty-six nights. I have carefully traced the radiant point during this period as it successively assumes positions to the eastward though the displacement is far less rapid than that observed in the case of the *Lyrids*. I select nine positions derived from a mean of all my observations:—

Date.	Radiant Point.	Horary No. of Meteors.
July 26.....	$27 + 55$	1
29.....	$30 + 55$	3
August 1.....	$33 + 56$	5
4.....	$36 + 56$	6
7.....	$40 + 57$	10
10.....	$45 + 57$	57
13.....	$51 + 57$	7
16.....	$59 + 57$	3
19.....	$68 + 57$	1

The shower advances through 41° of R. A. ($=22\frac{1}{2}^\circ$ at equator) during the period of its display. After the maximum on the night of August 10 the displacement of the radiant is considerably more rapid than before it, and the decline of the shower is more abrupt than its increase. I believe the display really extends to August 22, for on that date in 1884 I suspected feeble traces of it from the point $77^\circ +56\frac{1}{2}^\circ$. Its tenuity on the occasion referred to may be understood when I mention that its estimated strength was about one meteor in three hours for one observer! This shower of *Perseids* supplies very swift meteors, almost invariably accompanied with streaks. Their observed motions and appearances during the period from July 25 to August 19 are very similar. When the radiant is rather near the horizon, in the early part of the night, the meteors apparently move slower and have much longer paths than when the radiant has attained a great altitude.

The November Meteors (Leonids).—This shower has been very inconspicuous during the last ten years. The parent comet (I 1866) was at its aphelion in 1882 outside *Uranus*, so that bright displays of meteors were not to be expected. On the morning of November 14, 1879, I saw a few fine members of this stream, but the return was not a notable one. Prof. HERSCHEL computes the radiant of TEMPEL's comet (I 1866) as $150.^\circ 5 + 23.^\circ 5$ November 13—, and I find the radiant point from my observations of the *Leonids* at $148.^\circ 3 + 22.^\circ 7$ November 13. The agreement is satisfactory, though the meteors apparently diverge from a point slightly west of the computed place from the cometary orbit. The shower certainly endures for eight nights (November 9–16), but I have not been able to determine whether there is any decided displacement in the radiant point during that interval. The recent displays have been so feeble and the weather in this climate is so rarely clear for several nights together in the autumn, that in this case my design has been frustrated. In 1879 and 1885, however, I fixed the radiant as follows:—

Date.	Radiant.
1879 November 13.....	148° +23°
1885 " 14.....	149 +21
1885 " 16.....	150 +22

The figures show a slight advance in the direction of increasing longitude, but the evidence is too meagre to be conclusive on the point. The meteors belonging to this stream are similar to the August *Perseids*. They are brighter than the average and move very swiftly, leaving vivid streaks upon their courses.

The Meteors of Biela's Comet (Andromedes).—This shower is apparently more recent than the others, especially in regard to its more imposing apparitions. Prof. HERSCHEL gives the radiant of BIELA's comet as $24.^{\circ}5 + 40^{\circ}$ November 27+. WEISS gave $23.^{\circ}4 + 43^{\circ}$ Nov. 28+ and HIND (1866) $25.^{\circ}25 + 42^{\circ}$ November 28+. From a discussion of the observations obtained during the great meteoric display of November 27, 1872, Prof. HERSCHEL found the central radiant at $25.^{\circ}1 + 42.^{\circ}9$ from a compact group of thirty-five positions. From the similar observations made during the equally brilliant return of the shower on November 27, 1885, I find the mean radiant at $23.^{\circ}7 + 44.^{\circ}3$ from thirty-three of the best positions. These several values for the cometary and meteoric radiant agree within small limits, and from whatever aspect the question is regarded, the identity of BIELA's comet and this celebrated meteor swarm appear conclusively demonstrated. The maximum number of meteors come just when the comet, or what remains of it, is not very distant from that point of the orbit intersected by the *Earth* on November 27. This is also true of the November *Leonids* with regard to the date of November 13. The *Andromedes* are very slow meteors with thick trains and short paths. The shower probably endures about a week and there is evidence of a slight retrograde motion of the radiant (MESSENGER, February 1886 p. 61) which however requires further investigation as it rests only on one year's results and the motion is inconsiderable.

In the instances of the *Leonids* and *Andromedes* the agree-

ments with Comets I 1866 and BIELA (1826) are very concise and exact. But in regard to the *Lyrids* and *Perseids* the resemblances are less striking because the periodical returns, either of the meteors or their parent comets are not yet determined. The other conditions are however eminently satisfactory. The displacements observed in the radiant points of the latter showers coupled with their durations may aid us in learning something as to the width and construction of those regions traversed by the *Earth*. Do the nightly variations in the radiant, as observed, correspond with that computed for extensive streams of meteors following the same general orbits as the Comets I 1861 and III 1862? The question is an important one and offers a new test as to whether the *Lyrids* and *Perseids* are actually associated with the comets to whose orbits they show such a striking resemblance.

In a subsequent paper, I hope to refer to another class of meteor showers which apparently endure for long periods, and maintain stationary radiant points. In concluding this note on the cometary meteor showers, I may mention that on about November 16 or 17, 1965 or 1966 the *Leonids* of TEMPEL's comet and the *Andromedes* of BIELA's comet will probably occur simultaneously! In the case of BIELA's comet there is a rapid retrograde displacement of the node which operates to bring the showers earlier every year. In 1798 BRAUDES at Hamburg saw the shower on December 7, whereas it now occurs on November 27. On the other hand the node of TEMPEL's comet is increased by planetary perturbations twenty-nine minutes of arc during one revolution of $33\frac{1}{2}$ years. Thus the displacement is in a contrary direction to that affecting BIELA's comet. The cumulative results of this will be apparent in constantly decreasing the interval of thirteen days which now separates the two meteor showers. In about 1965-66 when the *Leonids* will probably return in great strength, the *Andromedes* will also be due on about the same day and it is quite possible the two me-

teor showers may occur together and give rise to a spectacle, surpassing everything previously recorded, in the annals of meteoric astronomy.

BRISTOL, England, February 19, 1886.

ORBITS OF METEORS.

O. C. WENDELL.

For the Messenger.

The following twenty-eight orbits of meteor showers I have computed from DENNING's list of radiants as given in *SIDE-REAL MESSENGER* 1886, February No. p. 61.

Number	Day of Shower	Long. of Per.	Long. of Node	Inclination	Perihelion Distance	Motion
1885						
1	Nov. 14	17. 5	232. 3	59. 0	0.910	Retrograde
2	14	59. 0	232. 3	14. 5	0.996	"
3	16	54. 3	234. 3	15. 3	1.000	"
4	16	43. 2	234. 3	47. 6	0.991	"
5	17	82. 0	235. 4	39. 9	0.947	"
6	26	111. 5	244. 5	16. 6	0.841	Direct
7	27	109. 6	245. 5	16. 0	0.859	"
8	28	108. 1	246. 5	15. 7	0.874	"
9	30	107. 1	248. 5	14. 4	0.890	"
10	30	145. 4	248. 5	24. 9	0.613	"
11	Dec. 1	127. 2	249. 5	25. 3	0.767	"
12	1	92. 3	249. 5	75. 4	0.961	Retrograde
13	4	178. 5	252. 6	1. 3	0.363	Direct
14	4	221. 1	252. 6	55. 1	0.069	"
15	4	260. 2	252. 6	84. 5	0.005	Retrograde
16	4	352. 2	252. 6	70. 9	0.583	"
17	7	181. 8	75. 6	5. 8	0.360	Direct
18	7	227. 6	255. 6	87. 1	0.059	"
19	9	21. 7	257. 6	87. 8	0.781	Retrograde
20	9	81. 2	257. 6	83. 8	0.999	Direct
21	10	186. 8	258. 7	49. 9	0.344	"
22	10	221. 8	258. 7	37. 7	0.100	"
23	10	232. 7	258. 7	79. 8	0.051	"
24	10	338. 8	258. 7	58. 6	0.414	Retrograde
1886						
25	Jan. 2	100. 1	282. 1	75. 2	1.000	Direct
26	2	227. 0	102. 1	9. 3	0.214	"
27	2	15. 4	102. 1	3. 3	0.529	Retrograde
28	5	187. 8	285. 1	48. 2	0.564	Direct
Comet 1873 VII						
"	1884 I	85. 5	248. 6	26. 5	0.770	Direct
"	1884 I cor.	93. 4	254. 2	74. 1	0.776	"
"		95. 9	257. 6	83. 5	0.778	"

There is a marked resemblance between meteor elements Nos. 11 and 20 and those of comets 1873 VII and 1884 I (Pons-Brooks) respectively, as will be seen above. In the first case there is a very close agreement in all the elements save the longitude of perihelion. In the second, there is a general resemblance in all the elements with those of the Pons comet, although it is not as close as could be desired. If, however, we assume that the meteoric stream has a considerable breadth, at the node, which is perfectly admissible, we may determine the resulting change in the other elements, or, suppose we apply the change to the comet's orbit, which will answer equally well. Then meteor node — comet node = $d\Omega = +3.^\circ 4$. Now when $d\Omega$ is not large we have the following differential expressions.

$$\begin{aligned} d\pi &= 2 \sin^2 \frac{1}{2}i \, d\Omega \\ di &= \sin i \cot(\pi - \Omega) \, d\Omega \end{aligned}$$

Solving these equations we obtain for $d\pi + 2.^\circ 5$ and for $di + 9.^\circ 4$, and these applied to the comet's perihelion and inclination give for $\pi \, 95.^\circ 9$ and for $i \, 83.^\circ 5$ as appear above in the last case in the table which I have called Comet 1884 I corrected. Then we shall also have for q (the anomaly being determined with reference to the descending node.)

$q = R \sin^2 \frac{\Omega + d\Omega - \pi - d\pi}{2}$ which, being solved, gives $q = 0.778$, as before.

This general agreement, although quite marked, cannot yet be regarded as conclusive from the fact that the orbit of the comet is about two-tenths the *Earth's* distance from the *Sun* inside the *Earth's* orbit, and so would seem to preclude the possibility of meteors from such a distance reaching the *Earth*, although there is, beyond question, much lateral spreading in their orbits.

Farther observations, however, will undoubtedly throw more light on both these cases.

HARVARD COLLEGE OBSERVATORY, February 22, 1886.

THE PREDICTION OF FINE SEEING.

DAVID P. TODD. *

For the Messenger.

I find myself often wondering whether, in the elaborate records of meteorological observations at the command of the officers of the Signal Service, there may not be locked up, in great part, the data necessary for the prediction of fine seeing. It will appear that the matter is of the last degree of importance to the astronomer; for, in most kinds of work, there is, I think, a strongly marked tendency to restrict observation to the better nights, and to let the very bad ones, however clear the sky, pass unused. If, as a practical matter, fine seeing can be promised the astronomer one or two days, or even a few hours ahead of time, it would be of the greatest assistance in enabling him to plan his work accordingly.

But for the present solution of the problem we need, first, a considerable series of concerted observations of the conditions of vision, night after night, at ten or twelve observatories. From these, all local and immediate causes of bad vision must be carefully eliminated. It may be expected, then, that the collation of these observations with the appropriate meteorological data, will suggest to those expert in such matters, the proper connection between the two. At the very least, it can be ascertained whether the upper or the lower atmosphere affects the seeing more. We naturally expect the latter to exercise the more powerful influence; and if it really does, the correct solution of the question is all the nearer at hand. But there are times within the range of experience of every observer when all ordinary indications of fine seeing are delusory, and the trouble appears to be in the upper atmosphere. Precise knowledge on these points would well repay the labor of deriving it; and there is no country where the research can be so advantageously prosecuted as in our own. Captive balloon-data would be of the utmost importance.

* Lawrence Observatory, Amherst, Mass.

At Amherst, near the center of Massachusetts, I conceive that the meteorological conditions for observational work are fully up to the average of the Eastern States. But I have found very few nights in which a power of 600 would give satisfactory results with my objective, a Clark glass of fine figure, and $7\frac{1}{4}$ inches aperture. Still more rarely are the conditions of exceptional vision permanent throughout the night. In general, the winter seeing is the worst; but I have had occasionally a fine night in the coldest weather. All told, the Spring and Autumn months are the best.

In something more than four years, I remember to have had only two nights on which the atmosphere was beyond criticism, both as to transparency and steadiness—nights when the telescope could be worked up to the full limit of its defining and illuminating power. One of these was the 6th of November, 1883, and the other the 9th of February, 1886. On neither of these, however, were these perfect conditions permanent throughout the entire night, the former suddenly turning into a pouring rain, while at 13h.5 on the latter, the seeing had become only ordinarily good, and was rapidly getting worse. Another night, the 7th of March, 1886, started in very well, but clouds came up soon after twilight had gone, and a good part of the night was thus lost. To begin the line of possible research, to which I have alluded, it might be well if others would examine their records of these nights, as some little light might thus be shed on the question whether fine seeing is only local or general.

AMHERST, MASS., March 16, 1886.

PROPOSED MAPS FOR TRACING METEOR PATHS.

T. W. BACKHOUSE.

I have long thought that the existing star-charts are inadequate for meteor observers.

The British Association maps prepared for them, though very

useful, seem not sufficiently accurate for present requirements. Many observers make their own maps by inserting in skeleton charts, drawn on a preferred projection, just such stars as they need. This appears an unnecessary individual expenditure of labor, as if suitable maps were prepared they would do for all engaged in shooting-star investigations.

I therefore propose to get some printed, and shall be glad to receive suggestions from meteor observers who have any to make on the subject.

The following points sketch my present plan; about those to which ? is added I feel more doubtful than as to the others:—

There should be fourteen maps, engraved with the utmost attainable accuracy, on the gnomonic projection, with centres at

R. A.	0°	D. ±90°	R. A.	0°	D. 0°
45	{	±45	90	{	
135			180		
225			270		
315					

Diameter 140°. Square; length of edge 24 $\frac{1}{2}$ inches. The maps will thus overlap each other a great deal, one advantage of which would be the facility of transference of a meteor-path from one map to another.

R. A. and D. circles to be finely drawn (in same coloured ink, and at same printing as the stars) for every degree of D., and for every degree of R. A. except near the poles. The R. A. and D. to be given in degrees marked at each interval of five; and the hours of R. A. to be marked also?

The sky to be represented as seen with the naked eye, but without the Milky Way. Stars and cumuli to be inserted to 6.5^m magnitude; and fainter stars also, separately, when they are cumulatively as bright, like as in the 'Uranometria Argentina' maps. To attempt completeness in this respect, all the stars to the adopted limit of magnitude in the catalogues of the 'Uranometria Argentina,' of the 'Harvard Photometry,' and of HEIS will be taken; and other catalogues consulted for supplying omissions, with the chief object of ascertaining the individual

stars of which the double and multiple stars in HEIS are composed, as he does not give them: about such catalogues information would be very useful and is solicited.

The positions of the stars to be taken from the various Greenwich (especially the Nine-Year for 1872) RADCLIFFE and Cape Catalogues; for the epoch 1900? An accompanying catalogue of the stars mapped to be printed, like those of ARGELANDER and of HEIS?

The name to appear in each constellation, and be frequently repeated—abbreviated (or by symbol for the zodiacal constellations?)—near its borders, to facilitate recognition of outlying stars [without it being necessary to show by lines the boundaries of constellations*]. The usual constellations to be adopted; not BODE's.

Every star to have a designation, and one only; to be taken in order, thus:—1. Greek letters; 2. In some cases, Roman capital letters, as in *Camelopardus* and for variable stars; 3. FLAMSTEED's Nos.; 4. Roman small letters; 5. B. A. C. Nos.; 6. Nos. from the 'Uranometria Argentina' to be distinguished by G (for GOULD)?; 7. Nos. from 'Harvard Photometry' (H. P.)?; 8. LALANDE's (Ll.) Nos. ?; 9.....? [Nos. from HEIS ?; 10.....?. But in some cases where a pair of stars has one name, it may be needful to give not only this name, but the designations of both stars. Where more than one star has the same Greek letter, as α^1 , α^2 *Orionis*, it would probably be advisable to follow the order of R. A. in the numbering. But on the whole question of nomenclature it will be matter for consideration whether to adopt GOULD's rules or those of some one other standard authority.*]

Many observers give the position or direction of meteors observed in degrees of R. A. and D.; while others make reference to stars. The latter method seems to be simpler and more exact; but it is unsatisfactory on turning to a map to find that

* Added by E. F. SAWYER, Cambridgeport, Mass., in answer to personal request by the author for his views.

stars conspicuous in the heavens are wholly omitted, or marked in without a name of any kind, The above suggestions are made with a view to supply such deficiencies.

Magnitudes to be represented by black circles of various sizes: perhaps with a white centre to the brighter stars ?, shaped differently, as in PROCTOR's 'New Star Atlas,' care being taken that the white and black have one center. [The authorities for magnitudes being the 'Uranometria Argentina,' 'Harvard Photometry,' and the Uranometria Nova Oxoniensis,' all the magnitudes to be reduced to one standard.*] Stars that vary considerably to be depicted of the minimum magnitude, with surrounding circle of maximum.

All designations of stars to be in ink of some other color than that for the stars themselves—say blue?

Precession to be shown in various parts of the maps, in some such way as in PROCTOR; exhibiting apparent motion of stars in one hundred years relatively to lines of R. A. and D. Perhaps this would involve giving lines of latitude and longitude also.

The position of the horizon, say of Greenwich, at midnight, for fortnightly intervals, to be shown by a line, on both edges of each northern and equatorial map; with an accompanying list of hours at which the horizon has the same position on other dates.

A copy of each of the three patterns of lines of R. A. and D. used in the fourteen maps to be printed on tracing-paper, and supplied with each set of maps. Means should be afforded of measuring 1° in every direction at any part of a map.

The sets of maps not to be bound, but each map be separately removable from a cover.—*In February Observatory.*

BIELA'S COMET.—The story of BIELA's comet, as told by Prof. H. A. NEWTON, in a lecture delivered before the Sheffield School, Yale College, is being reprinted in *Nature*.

* See foot note, p. 116.

ELEMENTS OF THE ORBIT OF COMET BARNARD 1886.

J. MORRISON PH. D., F. R. A. S.*

These elements are founded on the observations made at Munich on December 12, 1885, January 21, 1886, and at Washington on March 1, 1886, which are as follows:—

Munich M. T.				R. A.			Dec.		Comp. Star.
d	h	m	s	h	m	s	°	'	
Dec. 12	11	52	55	4	0	14.77	+5	33 36.2	<i>Tauri</i> Ber. Jahr.
Jan. 21	7	6	27	2	31	29.01	+11	59 59.1	31 <i>Arietis</i> 9 Yr. Cat.
Washington M. T.									
Mar. 1	7	39	48.1	1	56	28.44	+21	11 40.9	W (2) 1h; 1210.
"				1	56	28.39	+21	11 40.7	W (2) 1h; 1217.

The first and second were taken from the *Astronomische Nachrichten* No. 2709 and the mean of the Washington observations was used as the third, all of which were corrected for aberration and parallax by means of approximate parabolic elements previously computed.

As the observations have conducted to hyperbolic elements which will require further confirmation, we give here the principal results obtained during the computation in order to show the degree of accuracy to which it has been carried.

From the approximate parabolic elements the first values of P and Q are derived as below. The notation employed is the same as that of WATSON'S Theoretical Astronomy.

	I	II
log. P	0.0097530	0.0097462
log. Q	9.7170577	9.7170622
z	26° 19' 25."943	26° 19' 25."528
log. m_0	9.8916592	9.8916612
z'	28° 41' 54."63	28° 41' 54."094
log. r'	0.3078051	0.3078071
log. ρ'	0.2171495	0.2171524
log. ρ	0.2106958	0.2106942
log. ρ''	0.2389634	0.2389680

* Assistant on the American Ephemeris and Professor of Chemistry, National University, Washington, D.C.

l	67° 23' 3."833	67° 23' 3."90
l'	68 5 38. 165	68 5 37. 643
l''	69 22 32. 234	69 22 30. 663
b	-9 27 42. 069	-9 27 42. 024
b'	-2 14 44. 702	-2 14 44. 717
b''	+10 48 44. 672	+10 48 44. 663
$\log. r$	0.4147679	0.4147669
$\log. r''$	0.1500719	0.1500786
Ω	68° 18' 44."184	68° 18' 43."486
i	84 27 0. 123	84 27 4. 648
$\frac{1}{2}(u''-u')$	6 33 36. 5115	6 33 36. 552
$\frac{1}{2}(u'-u)$	3 37 30. 5920	3 37 30. 4535
$\frac{1}{2}(u''-u)$	10 11 7. 1035	10 11 7. 0055
$\log. s^2$	0.1133348	0.0133345
$\log. s'^2$	0.0055391	0.0055391
$\log. P_1$	0.0097462	0.0097461
$\log. Q_1$	9.7170622	9.7170626
$\log. X$	-0.0000068	-0.0000001
Y	+0.0000045	+0.0000004

The three values of $\log. p$ (the semi-parameter) are 9.9818784, 9.9818782 and 9.9818784, which prove the accuracy of the entire computation up to this point. On completing the computation from the extreme values of r and u , as thus obtained the following hyperbolic elements are found:

$$\begin{array}{l}
 T = 1886 \text{ May } 3.06939 \text{ Washington M. T.} \\
 \omega = 119^\circ 34' 50."649 \\
 \left. \begin{array}{l} \Omega = 68 \ 18 \ 43. \ 486 \\ i = 84 \ 27 \ 4. \ 648 \end{array} \right\} \text{Mean Equinox } 1886.0 \\
 e = 1.00067106 \\
 \log. a = 2.8539414 \\
 \log. q = 9.6807028
 \end{array}$$

The three values of T come out thus, Dec. 154.06939*d*, Dec. 154.06940*d* and Dec. 154.06940*d*, and therefore the residuals for the middle place are zero.

JUPITER.—The great red spot on *Jupiter* presents the same outlines as in former years. January 25, when the seeing was exceptionally good, it showed a patch of white over the middle, giving a ring form to the spot, the same as seen during the last opposition, only not so conspicuous. The ephemeris based on the observations of the two previous oppositions represents very closely the position of the spot on the disk. G. W. H.

EDITORIAL NOTES.

GALLE'S Catalogue of Comets from 1860 to 1884, as translated by W. C. WINLOCK, from the German, in *Astronomische Nachrichten*, (Nos. 2665 2666) will be sent to any address on receipt of fifty cents.

THE NAVAL OBSERVATORY.—The Secretary of the Navy, some months ago, asked the advice of the National Academy of Sciences, on the following points:—

1. As to the expediency of making the change in the time of beginning the astronomical day, recommended by the International Meridian Conference of 1884.

2. As to the advisability of asking Congress to make an appropriation for the observation of the total eclipse of the *Sun* to occur in August, 1886.

3. As to the advisability of proceeding promptly with the erection of a new Naval Observatory upon the site purchased in 1880.

The Academy through its appropriate committee has recently made a report giving its advice in clear and decisive language.

On the first point, the committee recommends that a change in the beginning of the astronomical day be made, as soon as sufficient concert of action can be secured among leading astronomers and astronomical establishments of the civilized world, in 1890 if practicable; if not, in 1900.

2. The committee decline to recommend the application for an appropriation to aid in observing the solar eclipse of August, 1886.

3. On the third point, after a very full consideration, the committee unanimously reported as follows:—

- (1) It is advisable to proceed promptly with the erection of a new Observatory upon the site purchased in 1880 for this purpose.

- (2) It is advisable that the Observatory so erected shall be, and shall be styled, as the present Observatory was styled origi-

nally, the "National Observatory of the United States," and that it shall be under civilian administration.

(3) It is advisable that the instruments in the present Observatory, with the exception of the 26-inch telescope, the transit circle, and the prime vertical transit, shall be transferred to the observatory at Annapolis, with such members of the astronomical staff as may be required to operate them; also that such books of the library as relate chiefly to Navigation shall take the same destination; the instruments above particularly specified, with the remainder of the library, being reserved as part of the equipment of the new National Observatory, to which also the remaining officers of the astronomical staff shall be assigned for duty.

(4) It is advisable that the Observatory at Annapolis should be enlarged, if necessary, and adapted to subserve as effectually as possible the wants of the naval service, whether practical, scientific, or educational; that it shall be under the direction of the Department of the Navy, and shall be styled the Naval Observatory of the United States.

After reading the entire report of the committee and the various letters and papers appended thereto, any candid person will say that the action of the committee was right, needful and wise, and, it is to be hoped, that Congress will soon take notice of these matters and put them on a just basis.

CHRONOGRAPH PENS.—In the December number of this journal, Prof. E. S. HOLDEN has a note on chronograph pens, and recommends one which requires filling every twenty minutes.

I think the necessity for so frequent attention is a fatal defect. At the Dearborn Observatory, both the Meridian Circle and the Equatorial, are so far away from the chronograph that it is necessary to use a pen which does not require frequent refilling, and also one that is absolutely certain to write without clogging. I soon found that the ordinary glass pen required close watching. I made a great many experiments, and tried numerous devices to secure a pen which was certain to write with any ordinary ink, and finally adopted a right line drawing pen. It is constructed on the same plan as a drawing pen, but without an adjusting screw, which is not necessary. I have had one of these pens in use for a couple of years, during which

period it has never clogged. The blades are seven-eighths of an inch in length and one-quarter inch wide at the top. This pen will record on the chronograph sheet for forty-five minutes without re-filling. It may be filled by plunging in the ink bottle. If kept clean when not in use I presume it would last for a number of years.

Previous to the construction of the pen described, I used a right line pen, with a small brass cup soldered on one of the blades, in which was coiled a spiral of very thin copper. A small hole was drilled in the side, so that there was communication between the cup and the pen. The cup was one-half inch in diameter and three-eighths inches deep. It would hold ink enough to record for a number of hours without re-filling. The spiral of copper kept the ink from running out by capillary attraction.

One may get a heavy or fine line, simply by making the point of the pen sharp or blunt. This kind of a pen will record on the chronograph sheet—riding on the side on one blade, or used in the ordinary way. I presume a right-line pen, with index and longer blades than the one described, might be made to hold ink enough for two hours' recording.

G. W. HOUGH.

ELEMENTS OF COMETS FABRY AND BARNARD.—The computation of Comet Fabry seems to indicate that that body is identical with Comet 1790 III. The plane of this comet's orbit and also that of BARNARD's comet are nearly perpendicular to the plane of the ecliptic, and also to the line of sight from the *Earth*. They are thus favorably situated for the determination of the position in its own plane, or, in other words, of the elements $\pi - \Omega$, the perihelion distance and the time of perihelion passage; but very unfavorably situated for the determination of the inclination and also of the node. We shall have to wait until the *Earth* approaches nearer to the plane of the orbits before a very accurate determination of these elements can be made. It would not be surprising if Comet Barnard should prove to be identical with Comet 1785 II, and Comet Fabry with Comet 1790 III. Should this be the case, they will probably be seen

in the north-western sky, early in May, with tails six or eight degrees in length. The identity is by no means established, but there is a strong probability in favor of it. S. J. CORRIGAN.

WASHINGTON, March 9, 1886.

SATURN AND μ GEMINORUM.—I was quite disappointed in not being able to observe the close conjunction of *Saturn*, with star μ *Geminorum* on January 9 last.

The following observations were made:

1886 January 9d 9h 15m (75°) M. T. Clouds had cleared away sufficiently to see *Saturn* and stars in its vicinity. With naked eye could not separate star from planet. Neither could I with opera-glass, although stars of the magnitude of μ were plainly seen with naked eye.

10h 30m. With a fairly good telescopic observation μ *Geminorum*—by eye estimate—appeared distant about the major-axis of ring from conjunction with preceding edge of ring. Star appeared reddish. Clouds prevented observation at time of conjunction.

A. C. P.

A LIST OF THE WARNER PRIZES.—Agreeably to your request, I send a correct list of the WARNER astronomical prize awards with the names of the recipients, as follows:

Oct. 10, 1880	SWIFT	\$500	A periodic; Special.
May 1, 1881	SWIFT	200	
July 13, "	SCHAEERLE	200	
Sept. 17, "	BARNARD	200	
Nov. 16, "	SWIFT	200	
Sept. 13, 1882	BARNARD	200	
Feb. 23, 1883	BROOKS	250	Special.
Sept. 1, "	BROOKS	200=Comet 1812.	
July 16, 1884	BARNARD	200	
July 7, 1885	BARNARD	200	
Aug. 31, "	BROOKS	200	
Dec. 2, "	BARNARD	200	
" 26, "	BROOKS	200	
		\$2950	\$2950

Comet Essay, BOSS.....	200
Red Sunset 1st Prize, K. J. KEISSLING, Hamburg.....	200
“ “ 2nd “ JAMES E. CLARK, York, England..	150
“ “ 3rd “ Rev. S. E. BISHOP, Honolulu.....	50
“ “ 3rd “ Mr. H. C. MAINE, Rochester, N. Y.	50
Remuneration to Judges.....	150
Total.....	\$3750

Several essayists will receive medals of honor. The judges were Prof. DANIEL KIRKWOOD, of Bloomington, Indiana. Prof. M. W. HARRINGTON, Ann Arbor, Michigan. Prof. ORMOND STONE, University of Virginia, Virginia.

There was a tie between BISHOP and MAINE, and rather than trouble the judges again Mr. WARNER gives each the offered special prize.

It is probably well known that Mr. WARNER only offered one prize of \$200 for the best paper, but among the thirty-five received, so many were almost equally interesting and instructive and on which so much thought and labor had been bestowed by their authors, he informed the judges that he would give \$100 (which he afterwards increased to \$150) for the second, and \$50 for the third best paper.

Nearly all the authors take the ground that the phenomenon is caused by some kind of foreign matter in the upper atmosphere, but they are not agreed as to the source from whence it came. As Prof. KIRKWOOD in a private letter remarks “after all, the rapid motion of the Krakatoa dust westward is still unexplained.”

The WARNER Comet Prize is continued from March 1 1886 to March 1 1887. It is reduced to \$100, but is open to the world.

LEWIS SWIFT.

WARNER OBSERVATORY, March 13, 1886.

COMETS FABRY AND BARNARD.—As these interesting comets grow brighter, amateurs who have small telescopes or opera-glasses, may do real service in their study, by making sketches of them, at every opportunity, exercising care to plot all stars

in, or very near, the tail of each one as accurately as possibly. Local time to nearest five minutes is also desired, by which astronomers may identify the stars and make the sketches useful in increasing the number of observations for detailed study of the theory of cometary tails. Assistant H. C. WILSON, of the Cincinnati Observatory, will give attention to this subject as related to these comets, and any such observations sent him will contribute to a worthy purpose.

DOUBLE STAR A. C. 5 (8 SEXTANTIS).—This star is worthy of some attention by observers just now. It was discovered in 1852 by ALVAN CLARK and was first measured by DAWES in 1854. The position angle was then 50° and the distance about 0."5. Since then the distance has decreased and the observed position angles do not agree at all well. In 1881 BURNHAM could detect no elongation. On the nights of March 4 and 6, 1886, I observed the star with the 11-inch equatorial. The elongation was very plain, but I could not separate or even notch the stars with power 450. The mean of the two nights measures gives about 130° for the position angle. The star is probably a rapid binary. Its position is $9^h 47^m - 7^\circ 32'$; magnitude 6.0 and 6.5.

H. C. WILSON.

DARK TRANSIT OF JUPITER'S SATELLITE III.—Observers have frequently recorded the fact that *Jupiter's* fourth satellite appeared dark while in transit across the disk of the planet, but I do not recall an instance where this phenomenon has been noted with regard to satellite III. On the night of March 6, 1886 at $12^h 40^m$, Mt. Lookout mean time, I noticed that the third satellite in transit appeared quite dark. It was then traversing one of the dusky circumpolar belts on the northern hemisphere of the planet and appeared much darker than the belt. The shadow of the same satellite was near the following side of the disk traversing the white belt immediately south of the one just mentioned, and was of inky blackness. The shadow of satellite II was just entering upon transit.

H. C. WILSON.

ASTRONOMICAL WORK FOR AMATEURS IN PREPARATION.—From a recent private letter, we were much interested to learn that Mr. WESTWOOD OLIVER has in preparation a practical manual of "Astronomical Work for Amateurs." He has for his assistance prominent Fellows of the Royal Astronomical Society, whose names are favorably known in America, such as the following: E. W. MAUNDER, W. F. DENNING, T. E. ESPIN, A. C. RANYARD, T. S. ELGER, J. E. GORE, J. R. CAPRON, HOWARD GRUBB, W. S. FRANKS, T. W. BACKHOUSE and others. The aim of this work will be to help the persons of limited instrumental means, to turn their attention to astronomical researches of real scientific utility, special attention being directed to the comparatively new fields of spectroscopy and celestial photography. The book will be published by Messrs. LONGMANS & Co. Mr. OLIVER invites suggestions from practical workers, which may be sent to him at Lochwinnoch, Scotland.

THE RED SUNSETS.—The sun-glows have greatly diminished during the last six months, and a short summary of very full records kept during that time presents some interesting items not heretofore published.

The tabular statement below exhibits the number of observations of red sunrise or sunset, and midday halo for six months, using only such as were made on days when the atmosphere was unquestionably clear, carefully excluding such "white-sky" days as former experience has demonstrated to be capable of hiding from sight, any amount of glow.

Up to last August, the richer glow had been invariably accompanied by cooler weather, but with the last of August, the reverse began sometimes to be noticed. On several of the latter occasions the color extended beyond its usual limits.

A rich midday halo has sometimes followed a morning devoid of color, and a rich sunset has closed a day which gave no halo.

Some of these variations can be readily accounted for by atmospheric changes, but scarcely so the thirteen days in the table when there was no color.

On these days special note was made that the sky was deci-

dedly blue and clear. Nine were for halo and four for sunset.

	Falling Temp.	Rising Temp.
Midday Halo.....	19.....	6
Sunrise or Sunset.....	24.....	17
No Color.....	7.....	6

BALTIMORE, Feb. 16, 1886.

J. R. H.

TUTTLE'S COMET.—On account of the few observations made on this comet, it may not be uninteresting to insert the observations made by Prof. STONE at this observatory. The comet was described as large, round and pretty bright, and although brighter at the center was without any well-defined nucleus. It was only seen for a very few minutes after rising on account of the approaching twilight. The observations were made with the 26-inch equatorial, power 108 and square bar micrometer.

1885	G. M. T.	App. R. A.	log. $p \Delta$	App. Dec.	log. $p \Delta$
Sept. 15	21h 50m 23s	9h 22m 58s.22	9.655 n	-0° 48' 59".4	0.736
Sept. 16	21 40 51	9 26 8.08	9.659 n	-1 41 42.0	0.738

COMET (α) 1885 (BARNARD)—was observed a number of times at this Observatory during the months of July and August, and once on September 3, cloudy weather preventing further observation. Although Mr. EGBERT's ephemeris terminated on the 2nd, a rough extrapolation gave the place for the 3rd, with all needed accuracy. With power 175 the comet was seen without any difficulty, although the night was poor, appearing certainly as bright as many nebulae described in the General Catalogue as very faint. However when power 108, which contained the bar micrometer, was used the comet became so faint that it could not be seen at all when near the bars of the micrometer.

F. P. LEAVENWORTH.

LEANDER McCORMICK OBSERVATORY, March 11, 1886.

NEW INSTRUMENTS BY FAUTH & Co.—While in Washington recently, we visited the works of Messrs. FAUTH & Co., and as usual, found them busy finishing new instruments for orders waiting. That which first attracted our attention was their large new dividing engine. It is mounted on a solid stone pier, is constructed to divide the largest circles now in use, and is to

be provided with a case for constant temperature when at work. Messrs. FAUTH assured us that the engine will divide accurately to nearly one second of arc, by automatic action, and with the automatic error correction attachment small errors are further considerably reduced. The engine cost over \$7000.

Messrs. FAUTH & Co. have recently completed the following instruments:—

A large magnetic outfit for the Superintendent of the United States Navy Department. Largest ever made, cost \$1600.

A meridian circle for Buchtel College, to be more fully described hereafter.

A complete astronomical outfit for the University of California, consisting of 6½-inch equatorial, astronomical transit, zenith instrument, chronograph, spectroscope, etc.

A large astronomical transit, chronograph and mean time clock for the High School of Oakland.

We were also interested in noticing the new form of equatorial mounting that Messrs. FAUTH are now contriving. Among other improvements the attachment of a small chronograph to the pier to be operated by the equatorial driving-clock is a new and useful idea, at least, for some observers.

Primary Phenomenal Astronomy for Teachers and General Readers.
By F. H. BAILEY, Northville, Michigan, 1886. pp. 97, paper covers.
Price 25 cents.

Mr. BAILEY is doubtless already known to most of our readers as the inventor of two very useful pieces of apparatus for the general illustration of phenomenal astronomy, the "Astral Lantern," or Panorama of the Heavens," and the "Cosmosphere, or Miniature Universe." Particular notice of these will be given at another time.

Of late Mr. BAILEY has given attention to the preparation of a small book to show how primary phenomenal astronomy ought to be taught and studied. His work is for teachers and those who depend on self-help in pursuing this delightful branch. The plan is to study the phenomena and the theory of astronomy as related parts of this great science—the phenomena first, then the theory, as a consequence following clear and definite generalization, from the abundance of fact within easy reach of the ordinary student. In this plan of instruction, Mr. BAILEY is right unquestionably. His mode of studying the motions of the celestial sphere and the constellations is natural and systematic. Teachers in elementary astronomy will find this little book a help in presenting difficult points to young minds.

ASTONISHING



That not one teacher in — either understands or can readily explain :

1. Change of Season and Causes.
2. Tropics and Signification.
3. Zones and Origin.
4. Phenomenon of Midnight Sun.
5. Phases of Moon.
6. Twilight Belt.
7. Tides and Eclipses.

YET, ANDREWS' TELLURIAN

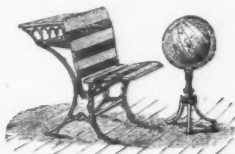
(SEE CUT)

Shows all these points clearly by Object Teaching.

In fact, this apparatus is a revelation to Teachers.

The Triumph School Desk

Dovetailed and Doweled together, takes
the Lead of all.



SIXTY KINDS OF GLOBES. ALL SIZES.

40 kinds of Blackboards, including Liquid Slating and the celebrated

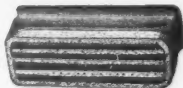


Which is put on as a black mortar, better than Stone Slate, and costing
say one-fifth as much.



THE DUSTLESS ERASER

Takes the lead by all odds, in durability, beauty and comfort. Ten sold to one of any other kind.



Crayons, Maps, Charts, Geometric Forms and Solids. Etc. Send for circulars to

A. H. ANDREWS & CO.,

195 Wabash Avenue, Chicago.

R. S. ALLEN,
MANUFACTURER OF REFRACTING
ASTRONOMI'L TELESCOPES,

of all sizes. Alt. Azimuth or Equatorial Mountings,
Objectives, Eye-pieces, Prisms and Accessories
Manufactured and Furnished at short notice.

NO. 136 WESTMINSTER STREET, PROVIDENCE, R. I.



VICK'S
Floral
Guide

Is a work of nearly 200
pages, colored plates,
1,000 Illustrations, with descriptions of the
best Flowers and Vegetables, prices of
and Plants, and how to get and grow **SEEDS**
them. Printed in English and German. Price only 10
cents, which may be deducted from the first order.

BUY ONLY VICK'S SEEDS, AT HEADQUARTERS.

JAMES VICK, SEEDSMAN, Rochester, N. Y.

CARLETON COLLEGE,
NORTHFIELD, MINN.

FULL PREPARATORY AND COLLEGIATE DEPARTMENTS.

ENGLISH, SCIENTIFIC, LITERARY and MUSICAL COURSES.

ALL DEPARTMENTS OPEN TO STUDENTS OF EITHER SEX.

EXPENSES VERY LOW.

The central office of the State Weather Service is located at Northfield and under the direction of Carleton College, affording special advantages for the study of Meteorology, and the Signal Service of the Government.

CALENDAR.

Spring Term begins Wednesday, March 31, and ends June 17, 1886.

Examinations to enter College, June 12 and 14. and Sept. 7, 1886.

Term Examinations, June 15 and 16, 1886.

Anniversary Exercises, June 14-17, 1886.

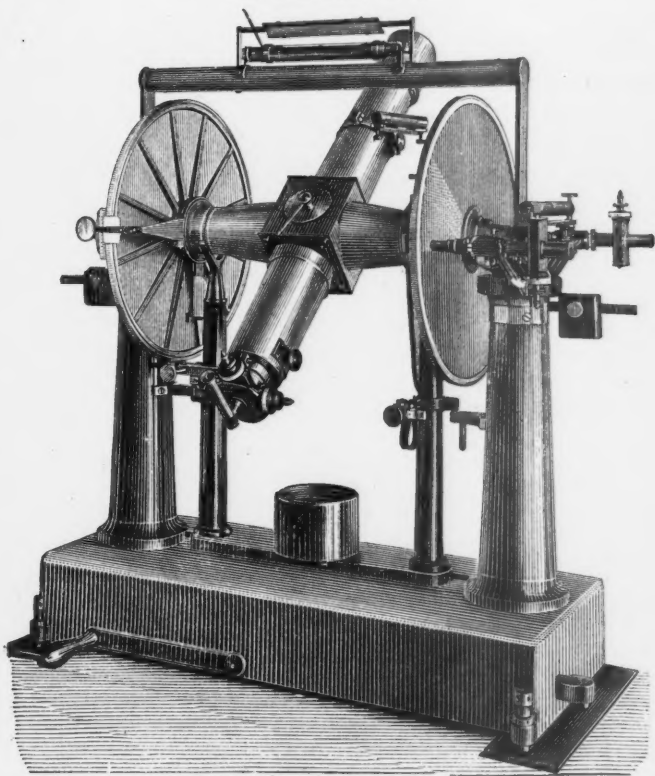
Exhibition at Art Room of work of Pupils in Drawing and Painting,
June 14-17, 1885.

Wednesday, September 9, 1883, Fall Term begins.

For further information address

JAMES W. STRONG, PRES. Northfield, Minn.

FAUTH & CO.
ASTRONOMICAL WORKS,
 WASHINGTON, D. C.



TRANSIT CIRCLE.—4 inch objective. 16 inch circles.

EQUATORIALS, TRANSITS, MERIDIAN CIRCLES,
ASTRONOMICAL CLOCKS, with Break-Circuit Arrangement,
CHRONOGRAPHS

Level Vials reading to single seconds; Eyepieces of all kinds, Micro-
 nometers, Spectroscopes, and Astronomical outfit of every kind. Also
 all kinds of instruments for higher Geodesy and Engineering purposes.

SEND FOR NEW CATALOGUE.

WARNER & SWASEY,
MANUFACTURERS OF
Observatory Outfits.

Transit Instruments, Chronographs, &c



of all sizes, with patent Frictionless Mechanism for RUNNING GEAR and SHUTTER.

OBSERVATORY DOMES,

6-INCH EQUATORIAL.

EQUATORIAL TELESCOPES,

From 6-inch aperture to the largest size.

WARNER & SWASEY, Cleveland, Ohio, U. S. A.